



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(54) Title: MASK</p> <p>(57) Abstract</p> <p>A mask (10, 10', 10'') for filtering dust and other particulates from air to be breathed by a person (14). The mask (10, 10', 10'') includes a compressible strip (30, 30', 30'') covered partially by a sealing material (32, 32', 32'') around the entire contact path between the mask (10, 10', 10'') and the person's face. The compressible strip (30, 30', 30'') provides for changes in the configuration of the face, while the impermeable material (32, 32', 32'') maintains a seal during all such changes.</p>			

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MASK

Field of the Invention

The present invention is directed to an inexpensive mask for filtering dust and other particulates from air.

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Background of the Invention

Masks for filtering dust and other particulates from air are known. In particular, a known mask has a hump-shaped, pliant layer of filter material formed to have an irregularly shaped perimeter to conform relatively closely to 10 a person's face. The mask forms an enclosure about the person's nose and mouth. The known mask includes a short piece of foam-like material in a region where the mask contacts the person's nose. Apparently, the foam-like material functions as a padding. A pair of straps are attached to the mask for 15 holding the mask to the person's head.

The problem with the known mask is that different people have different face configurations and, for that matter, the face configuration of a particular person changes as he breathes, talks, grimaces, or even as he becomes 20 fatigued during working, so that the known mask does not always conform to these various configurations and provide an appropriate seal. More subtly and more importantly, leakage may occur during normal breathing due to the natural spherical concavity formed by the position of the cheekbone, the 25 teeth, and the outer part of the jaw on both sides of the wearer's face. A pliant, muscular tissue covers these concavities to form the cheek. During inhalation, the pressure differential is such that it creates an external force pushing against the cheek area and forcing the cheek tissue 30 inward toward the inside of the mouth. During this process, the cheek tissue may be separated slightly from the perimeter of the known mask. Any slight separation provides an opening so that the small particulates which the mask is intended to filter may be forced into the space enclosed by the mask by

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the higher pressure which is outside the mask. The problem increases in magnitude anytime the jaw drops thereby increasing the area and depth of the indicated concavity. Although the indicated problem is subtle, the particles which 5 are to be filtered are smaller than the eye can see, and over time this deficiency in the known mask could lead to a serious situation.

Consequently, although the known mask meets the efficiency requirements with respect to the filter material, 10 the mask system which includes attachment to the wearer, often has a much lower efficiency since there either is an inadequate seal between the person's face and the mask at the time the mask is put on, or an inadequate seal develops at various times during the wearing.

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#### Summary of the Invention

The present invention is directed to solving the problems of the known mask. In this regard, the present mask includes a mechanism for filtering dust and other particulates from air, as well as a mechanism for pliably conforming the mask to a person's face and a mechanism for sealing between the person's face and the first material of 20 the filtering mechanism. The filtering mechanism is formed as a hump-shaped, pliant layer of first material wherein the 25 layer has an irregularly shaped perimeter to substantially conform to the person's face so that the hump-shaped layer encloses the person's nose and mouth. The conforming mechanism is attached to the filtering mechanism in an endless strip near the perimeter of the first material. The sealing mechanism is impenetrable to the dust and other particulates intended to be filtered from the air. The sealing mechanism is endless and is attached to both the strip of second 30 material and to the first material. The sealing mechanism leaves exposed an endless portion of the second material so

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that air can be forced out of and absorbed into the second material during compression and expansion without flowing through the sealing mechanism into space enclosed by the filtering mechanism.

5 More particularly, the endless strip is formed from a rectangular cross-sectional shaped, foam-like material which will readily compress and expand to conform to a person's face. One side of the strip is attached to the filter material. A third material, comprising the sealing mechanism, is attached to the side of the foam strip opposite the side attached to the filter material and extends for attachment to the filter material. In this way, the impenetrable material is in contact with the person's face, and provides a seal between the face and the filter material. One side of 10 the foam material is left free of the impenetrable material so that air may be forced out of or absorbed into the foam material during compression and expansion.

The present invention is particularly advantageous in that the foam material allows the mask to conform to the 20 person's face, including the concavities therein, during various configurations of the face. Furthermore, the seal between the face and the filter material is maintained as a result of the elastic, yet impenetrable, third material. Thus, with the present mask, the filter material can be made 25 to perform not only to a high efficiency, but such efficiency can be maintained by minimizing the likelihood of violations of seal integrity between the wearer's face and the filter material. Significantly, the advantages of the present invention are possible without requiring expensive design 30 details or manufacturing steps.

In a first alternate embodiment, a frame of rigid material is installed between the foam and the filter material of the mask to provide a rigid surface against which the foam may be compressed. In a second alternate embodi-

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ment, the filter function is provided by a smaller pad of filter material which is replaceable within a window-like frame and held in place by a cover. The window-like frame is formed as a part of a relatively rigid shell. Since the foam and sealing mechanism of the third material is attached to the shell rather than relatively flexible filter materials, the foam compresses against the shell in a fashion similar to the way it compresses against the relatively rigid frame of the first alternate embodiment.

10 These advantages and objectives of the present invention can be better understood by reference to the drawings, briefly described hereinafter, and by reference to the detailed description of the preferred and other embodiments which follows thereafter and refers to the drawings.

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#### Brief Description of the Drawings

FIGURE 1 is a perspective view of a person wearing a mask in accordance with the present invention;

20 FIGURE 2 is a side view of the person and mask of FIGURE 1, showing the mask in cross-section;

FIGURE 3 is a plan, rear view of the mask;

FIGURE 4 is a cross-sectional view, in perspective, of a portion of the mask which includes the sealing mechanism;

25 FIGURE 5 is a cross-sectional view, in perspective, similar to FIGURE 4 of an alternate embodiment;

FIGURE 6 is an exploded perspective view of an alternate embodiment mask in accordance with the present invention; and

30 FIGURE 7 is a cross-sectional view taken along line 7-7 of Figure 6.

#### Detailed Description of the Preferred Embodiment

35 Referring now to the drawings wherein like

reference numerals designate identical or corresponding parts throughout the several views, and more particularly to FIGURE 1, a mask in accordance with the present invention is designated generally by the numeral 10. Mask 10 is held by 5 straps 12 to the face of person 14 so as to enclose the person's nose and mouth.

As shown in FIGURE 2, mask 10 includes a layer 16 of first materials which function to filter dust and other particulates from air. As shown, layer 16 commonly includes 10 an outer material 18 and an inner material 20. In addition, it is understood that additional sheets of filtering first materials may be included as a part of layer 16. Each sheet of a first material may filter a different size or a different type of particle from air passing therethrough. In 15 addition, a plurality of sheets provides for the possibility of creating an air space between adjacent sheets so as to serve a further settling and filtering function.

Layer 16 is formed to have a hump-like shape so as to enclose the nose and mouth, but not contact them, when the 20 mask is against the person's face. The filtering layer is pliant and has a perimeter 22 which is irregularly shaped to conform substantially to a person's face. A seam 24 near perimeter 22 attaches the various first materials together. In addition, ridges or grooves 26 may be formed in one or 25 more of the first materials of layer 16 to provide structure for maintaining the shape of mask 10. A metallic member 28 may be attached with adhesive or in another known fashion to outer material 16 so as to fit over the nose of person 14. Member 28 is preferably readily malleable by hand so as to 30 easily conform mask 10 to the bridge of the nose.

Strip 30 is fastened with an adhesive or another known fastening mechanism to the inner material 20 of filtering layer 16 near perimeter 22. Strip 30 forms an endless path. Strip 30 is made from an open cell foam

second material and, preferably, has a rectangular cross-sectional shape. It is understood, however, that other cross-sectional shapes may function as well. In particular, it is only necessary that strip 30 have a first portion facing at least partially toward space enclosed by layer 16 and a second portion facing at least partially away from space enclosed by layer 16. The open cell foam allows air to be forced out of or absorbed into the foam during compression and expansion, in contrast to closed cell foam which reshapes or displaces rather than compressing and expanding.

A third material 32 also forms an endless path and attaches to both strip 30 and inner material 20. Third material 32 is elastic, impermeable to air, dust and other particulates to be filtered by layer 16 and is so soft that it cannot support its own weight.

As shown, strip 30 has a rectangular cross-sectional shape so that a first side is attached to inner material 20. Third material 32 covers either the first or second portion of strip 30, or, more particularly, is attached to a second side of strip 30 which is opposite from the first side and to a third side, as well as to a portion of inner material 20. In this way, the portion of third material 32 attached to the second side of strip 30 contacts the face of person 14 and provides an efficient seal between the face and inner material 20.

One or more straps 12 are attached to opposite side edges of filtering layer 16 so that when straps 12 are placed around the head of person 14, mask 10 is held securely to his face. More importantly, straps 12 are elastic or include adjustment mechanisms 34 so that mask 10 is held so tightly to the face of person 14 that strip 30 compresses to the more solid portions of the face, such as the cheek bone and jaw, and conforms to the concavities of the face therebetween. As

the configuration of the face changes or as masks are worn by different people, the compressibility of strip 30 provides for these various configurations and in conjunction with third material 32 maintains a seal thereby requiring 5 breathable air to pass through filtering layer 16.

The elasticity of the third material allows it to follow the various shapes of compression and expansion of strip 30. That is, third material 32 maintains attachment to strip 30 and allows strip 30 to conform to the configurations 10 of the face. In this regard, third material 32 must be so soft that it conforms to strip 30 and the face of the wearer and does not affect the performance of strip 30 during compression and expansion. As indicated, to function as indicated, third material 32 is sufficiently soft that it 15 will not support its own weight. In this way, the load (compression or expansion) of one segment of third material 32 is only locally transferred and does not globally affect the entire strip of third material. While third material 32 in combination with strip 30 seals an expanding and 20 contracting perimeter to the skin of the face, substantially stiffer or nonelastic materials do not allow a perimeter to expand and contract and maintain a seal and thus lead to gaps with the surface to be sealed or buckling of the material.

It is further noted that third material 32 may be 25 generally on the side of the strip 30 facing toward the space enclosed by layer 16 or on the other side. The important criteria is that third material 32 is attached to the side of strip 30 opposite the side attached to inner material 20 so that it contacts the face and that at least one of the other 30 sides is free of third material 32 so that air may be forced from or absorbed into the open cell foam strip 30 as it compresses and expands during wear.

To use, mask 10 is placed over the nose and mouth of person 14 and straps 12 are extended around his head.

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Straps 12 are adjusted so that third material 32 contacts the person's face at least partially all along the endless path of the third material. Also, strip 30 should be at least partially compressed all along its endless path. In that 5 way, third material 32 forms an efficient seal thereby preventing undesirable particles from bypassing filtering layer 16 and for the most part requiring air to pass through filtering layer 16 before reaching the person's nose or mouth.

10 Over time, as the configuration of the person's face changes due to smiling, grimacing, talking, breathing, etc., the foam strip 30 compresses or expands, but third material 32 always maintains a seal. During compression and expansion, air can freely flow into or out of strip 30 15 through the side of strip 30 which is free of third material 32.

A first alternate embodiment of the present invention is indicated by the detail shown in FIGURE 5. The embodiment of FIGURE 5 is the same as the preferred embodiment of 20 the other figures, except it includes a frame 36. For the sake of clarity, parts of the embodiment of FIGURE 5 which correspond with parts of the preferred embodiment are designated by exactly the same numerals, only the numerals are primed.

25 Frame 36 is made of a substantially rigid material, like plastic, and shaped to substantially conform to the face of the mask wearer near the perimeter of the mask. Frame 36 may be made from a hand shaped, semi-rigid material. Preferably, frame 36 is endless and is fastened with adhesive 30 or another known mechanism to the interior of the mask near the perimeter of the mask. Second and third materials 30' and 32' are then fastened to one another and to frame 36 in the same fashion as they are fastened to inner material 20 as described with respect to the preferred embodiment 10. In

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this way, frame 36 provides a more solid surface so that second material 30' may more readily compress between the face, especially the solid portions of the face, and frame 36.

5 Use of the first alternate embodiment is similar to the use of preferred embodiment 10.

A second alternate embodiment of the present invention is shown in Figs. 6-7. Parts of the second alternate embodiment which correspond with the preferred embodiment are 10 designated by exactly the same numerals, only the numerals are double-primed. The second alternate embodiment mask is generally designated by the numeral 10''. Mask 10'' has a shell 40 formed to have a hump-shape so as to enclose the nose and mouth, but not contact them, similar to material 15 layer 16 of mask 10. Shell 40 includes a window-like frame 42 for receiving a layer of first materials 44 which function to filter dust and other particulates from air. A cover 46 holds layer 44 in place.

Shell 40 has a perimeter 22''. A strip 30'' the 20 same as strip 30 is fastened with adhesive or other known fastening mechanism to shell 40 near perimeter 22''. Similarly, a third material 32'' the same as material 32 is fastened to both strip 30'' and shell 40, leaving one side of strip 30'' exposed to allow air to be forced from or absorbed 25 into the open cell foam material. As discussed with respect to the preferred embodiment, material 32'', therefore, forms a particulate impenetrable seal between the face and shell 40, while yet allowing the open cell foam strip 30'' to compress or expand as necessary.

30 Strap holders 48 are preferably made of the same material as shell 40 and form an integral part with it. Buckles 50 and attached straps are appropriately held by holders 48.

In a location approximately directly forwardly from

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where the mouth of the wearer of mask 10'' would be, frame 42 is formed. The size of frame 42 is not critical, as long as it is sufficiently large to allow sufficient air to the wearer during respiration for all respiration rates of the wearer. Frame 42 includes a flange 52 about its periphery. In addition, cross members 54 extend between pairs of opposite sides to form a grid across the opening 56. Layer 44 of filter sheets fit within and completely fill opening 56. A strip of adhesive or a sealing gasket (not shown) along the outer perimeter of layer 44 may be used to attach layer 44 to the outer edge 57 of opening 56 to insure that dirty air cannot bypass filtering layer 44 when passing from the outside of shell 40 to a space enclosed by it.

Cover 46 fits over layer 44 and attaches to flanges 52 of frame 42. Cover 46 is formed to have a rectangular frame 58 with cross members 60 and flanges 62 along preferably only one pair of opposite sides. Cover 46 is preferably slightly arcuate between flanges 62 so that flanges 62 may be separated when cover 46 is placed over frame 42. In this way, flanges 62 frictionally engage mating walls of flange 52.

In use, mask 10'' is placed over the nose and mouth of the wearer and appropriate straps fit around the wearer's head snugly. Strip 30'' compresses as appropriate and third material 32'' forms a seal as appropriate, both functions being adequately described hereinbefore with respect to the preferred embodiment. A pad of layer 44 is placed in the enclosure defined by flange 52 of frame 42. Cover 46 is bent slightly so that flanges 62 fit over opposite walls of flange 52 to hold layer 44 between cross members 54 and 60. The pad of layer 44 sheets may be installed in this fashion before or after mask 10'' is placed on the wearer.

Mask 10'' is particularly advantageous since shell 40 is relatively rigid and maintains its shape over extended

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5 use, even when it gets wet through perspiration or otherwise. The rigidity of shell 40 allows the straps of mask 10'' to be snugged as desired and, therefore, to compress strip 30'' perhaps more than one would with strip 30 of the preferred embodiment. In addition, sufficient filtering area is pro-  
10 vided to allow more than adequate airflow for respiration. Also, layer 44 is readily replaceable so that unclogged filtering sheets can be installed whenever needed. In contrast, a mask as disclosed for the preferred embodiment must be discarded whenever the filtering materials becomes  
15 sufficiently dirty.

Thus, the preferred and alternate embodiments of the present invention have hereby been disclosed in detail and advantages of structure and function pointed out. It is understood, however, that the embodiments are only exemplary of other possible equivalent embodiments. Therefore, it is understood that changes made, especially in matters of shape, size and arrangement to the full extent extended by the general meaning of the terms in which the appended claims are expressed, are within the principle of the present  
25 invention.

## WHAT IS CLAIMED IS:

## 1. A mask, comprising:

means for filtering dust and other particulates from air, said filtering means including a layer of first filter material, said filtering means having an irregularly shaped perimeter to substantially conform to a person's face; means for pliably conforming to said person's face, said conforming means being attached to said filtering means in an endless strip of second material near the perimeter of said filtering mean, said second material allowing air to be forced therein and thereout;

means for sealing between said person's face and said first material, said sealing means being impermeable, said sealing means being endless and attached to both said strip of second material and said first material, said sealing means leaving exposed an endless portion of said second material so that air may be forced out of and absorbed into said second material during compression and expansion without flowing through said sealing means into space enclosed by said filtering means.

2. A mask in accordance with claim 1 including a frame member attached to said filtering means near the perimeter of said first material and to said conforming means between said filtering means and said conforming means.

## 3. A mask, comprising:

means for filtering dust and other particulates from air, said filtering means including a layer of first filter material, said filtering means having an irregularly shaped perimeter to substantially conform to a person's face; means for pliably conforming to said person's face, said conforming means being attached to said filtering means

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in an endless strip of foam-like, second material near the perimeter of said filtering means, said second material allowing air to be forced therein and thereout so that said second material forms an expanding and contracting side 5 facing said person's face as the person's face moves through different expressions, said strip having a first portion facing at least partially toward space enclosed by said layer of first material and a second portion facing at least partially away from space enclosed by said layer;

10 a third sealing material covering one of said first and second portions and a portion of said layer of first material, said third material being impenetrable, said third material being elastic so that said third material readily stretches to the shape of the expanding and contracting side 15 of said second material so that said second material effectively functions to conform to the variable irregularities of the face while the third material effectively functions to seal; and

a strap attached to said filtering means for 20 wrapping about said person's head to hold said third material against said person's face and compress at least partially said second material whereby air flowing in and out of said second material during compression and expansion is directed by said third material which covers one of said first and 25 second portions to flow through the other of said first and second portions.

4. A mask in accordance with claim 3 including a semi-rigid frame member fastened between said layer of first 30 material on one side and said second material on the other side.

5. A mask, comprising:  
means for filtering dust and other particulates

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from air, said filtering means forming a hump-shaped, pliant layer of a plurality of first materials, said layer having an irregularly shaped perimeter to conform substantially to a person's face so that said layer encloses said person's nose  
5 and mouth;

means for sealing between said filtering means and said person's face, said sealing means including an endless strip of foam-like, second material, said strip having a rectangular cross-sectional shape with four sides, the first of  
10 said sides being attached to said filtering means near said perimeter, a second of said sides being opposite said first side, the second side of said second material expanding and contracting to conform to the irregularities in said person's face as the face moves through different expressions, said  
15 sealing means further including a third material, said third material being elastic and impermeable, said third material being attached endlessly to at least a portion of said second side and a third of said sides of said second material and a portion of said first material adjacent to said third side,  
20 said third material being elastic and sufficiently soft that said third material cannot support its own weight so that said third material readily stretches and takes on the shape of said second material at localized segments thereby allowing said second material to conform to the variable  
25 irregularities of the face while yet allowing said third material to seal effectively along its complete endless path;  
and

a strap attached to said filtering means for wrapping about said person's head to hold said filtering means to enclose said person's nose and mouth so that said second material compresses and so that said third material directs air forced out of and absorbed into said second material through a fourth of said sides, thereby preventing contaminated air from bypassing said filtering means through  
35 said sealing means.

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6. A mask in accordance with claim 5 including a semi-rigid frame member fastened between said hump-shaped layer on one side and said second and third materials on the other side.

5

7. A mask comprising:

means for enclosing a person's nose and mouth, said enclosing means having an irregularly shaped perimeter to substantially conform to said person's face and surround said 10 person's nose and mouth, said enclosing means including means for filtering dust and other particulates from air;

an endless strip of open cell foam attached to said enclosing means near said perimeter, said foam forming an expanding and contracting side facing said person's face as 15 the person's face moves through different expressions, said strip having a first portion facing at least partially toward space enclosed by said enclosing means and a second portion facing at least partially away from space enclosed by said enclosing means;

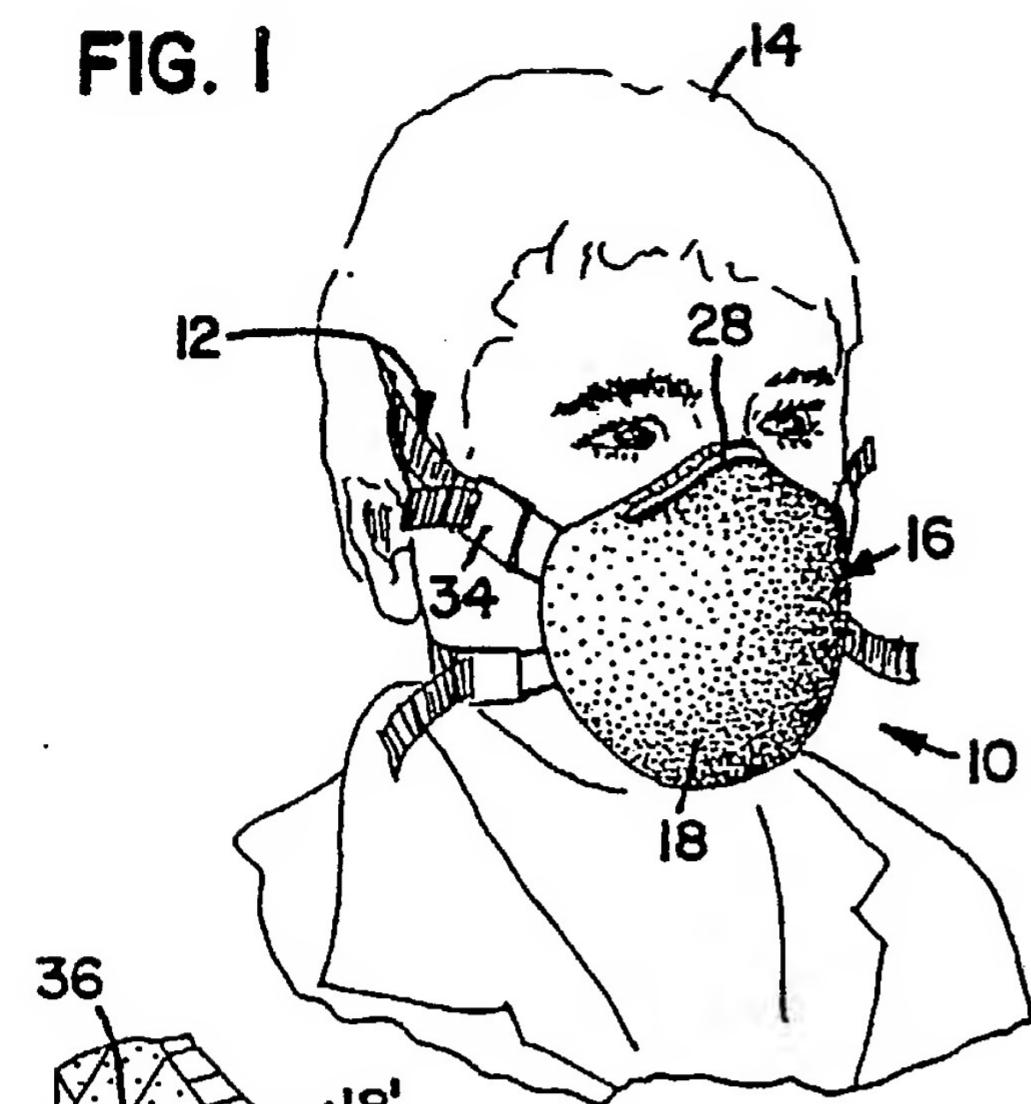
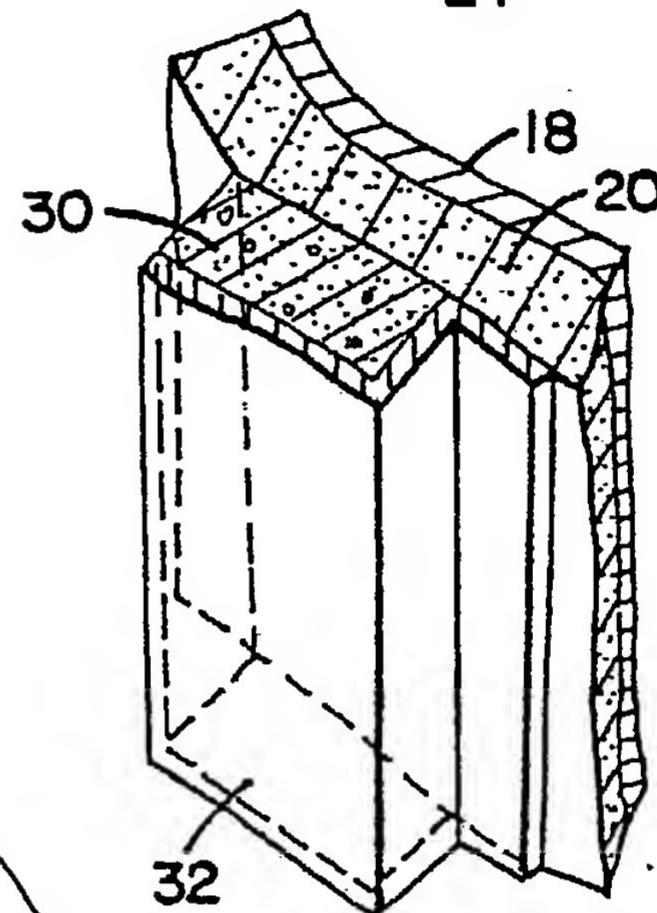
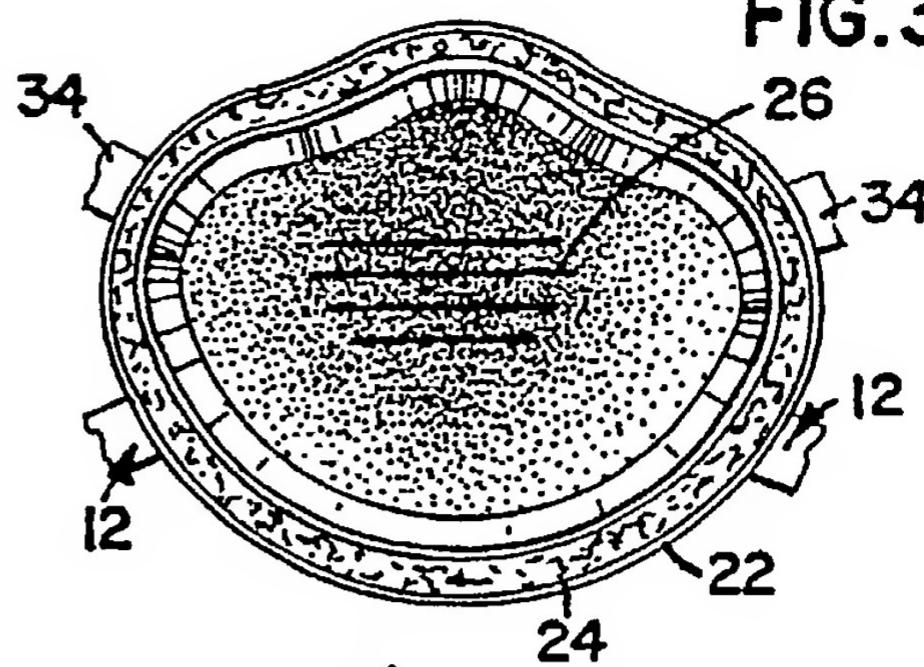
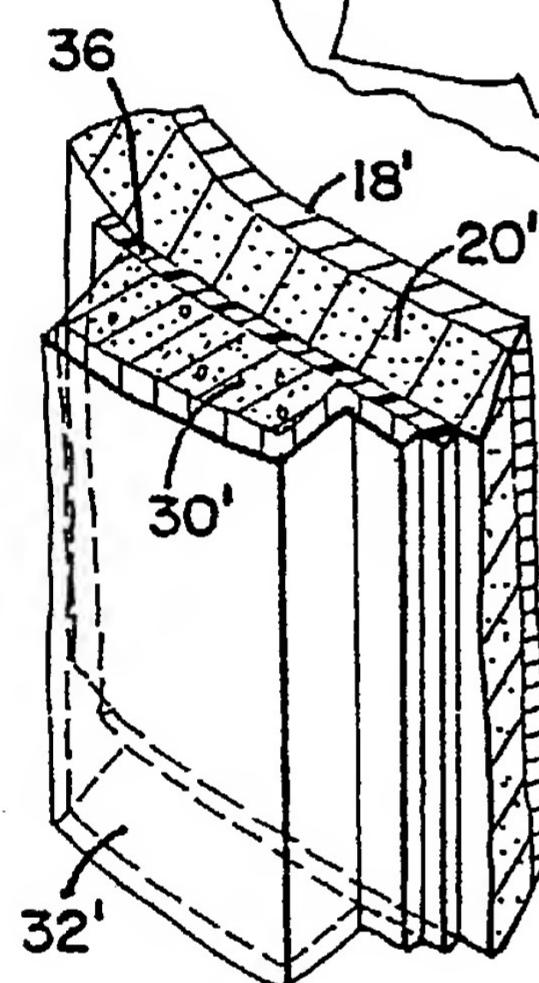
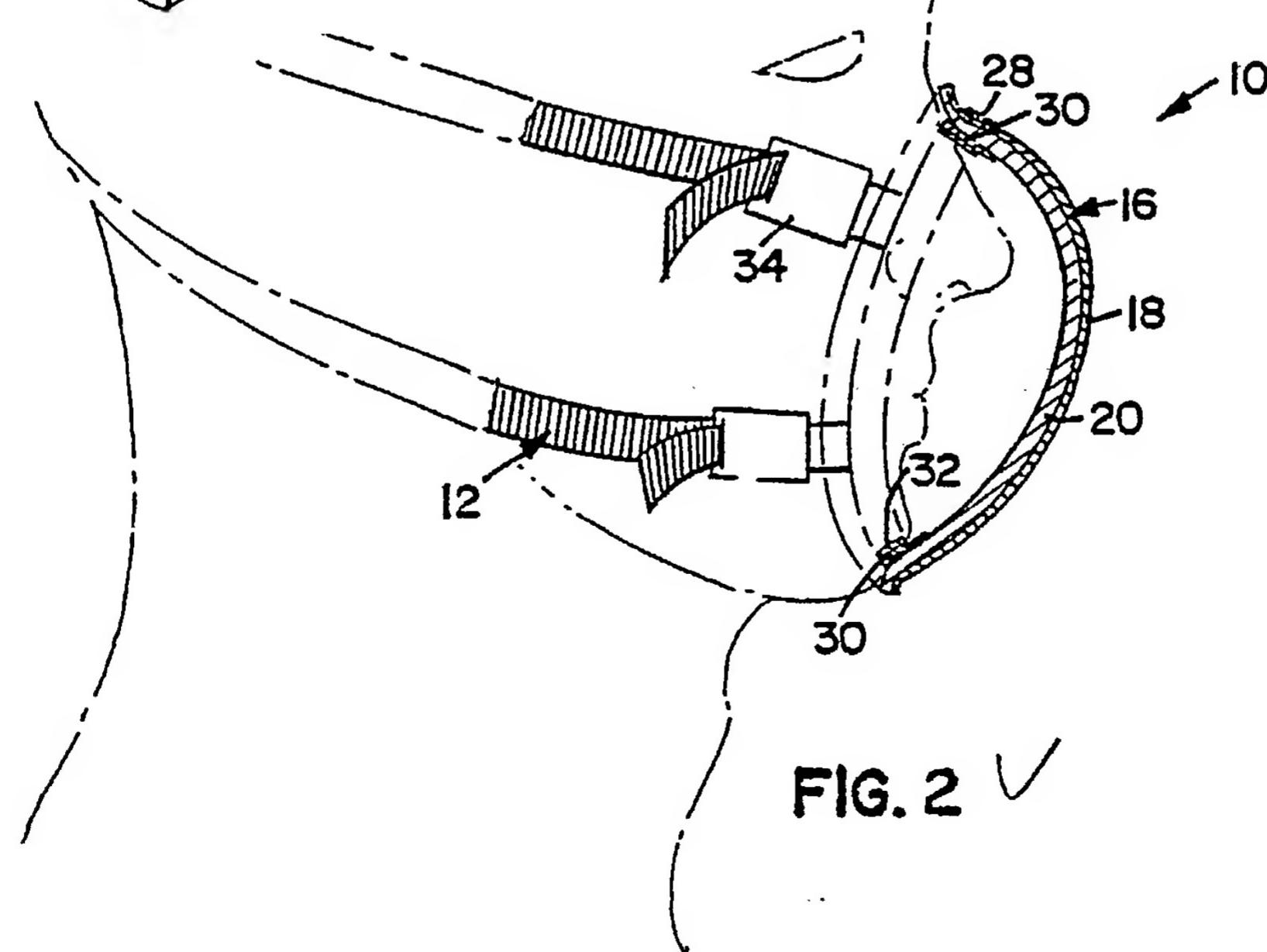
20 an elastic material following an endless path and covering one of said first and second portions and a portion of said enclosing means along said entire path, said material being impermeable to air and particulates; said material being so soft that it cannot support its own weight so that 25 said material can elastically stretch and take on the shape of the foam at localized segments thereby allowing said foam to conform to the variable irregularities of the face while yet allowing the elastic material to seal along its complete endless path; and

30 means for holding said enclosing means against said person's face to compress at least partially said foam whereby air flowing in and out of said foam during compression and expansion is directed by said elastic material to flow through the other of said first and second 35 portions.

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8. A mask in accordance with claim 7 wherein said enclosing means includes a semi-rigid shell, said shell having a frame defining an opening, said filtering means including a pad of filter material fitting in said frame,  
5 said filtering means further including a cover holding said pad in said frame.
9. A mask in accordance with claim 7 wherein said enclosing means includes a hump-shaped, pliant layer of  
10 filter material, said layer extending to said perimeter.

- 1 / 2 -

**FIG. 1****FIG. 3****FIG. 4****FIG. 5****FIG. 2** ✓

- 2 / 2 -

FIG.6

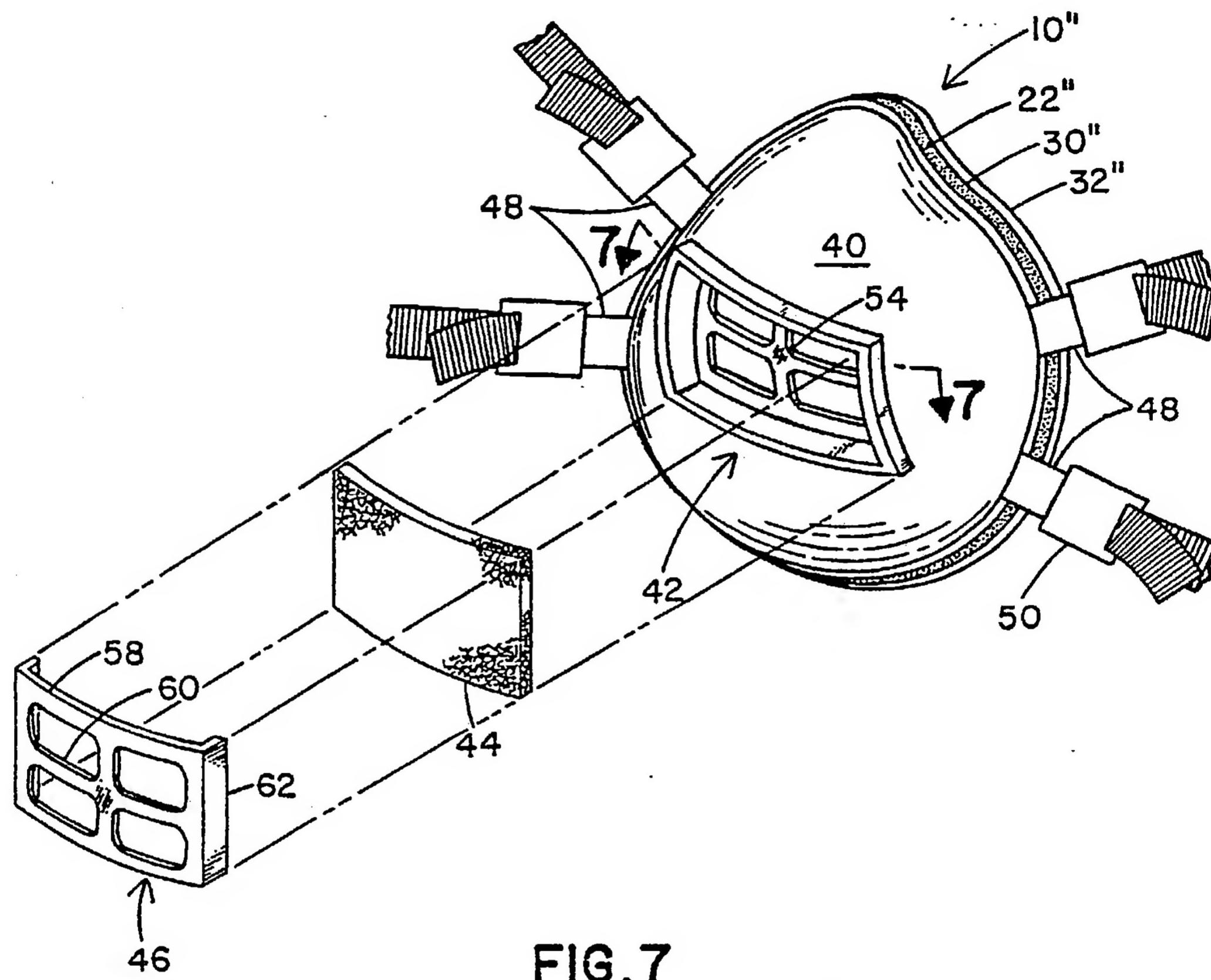
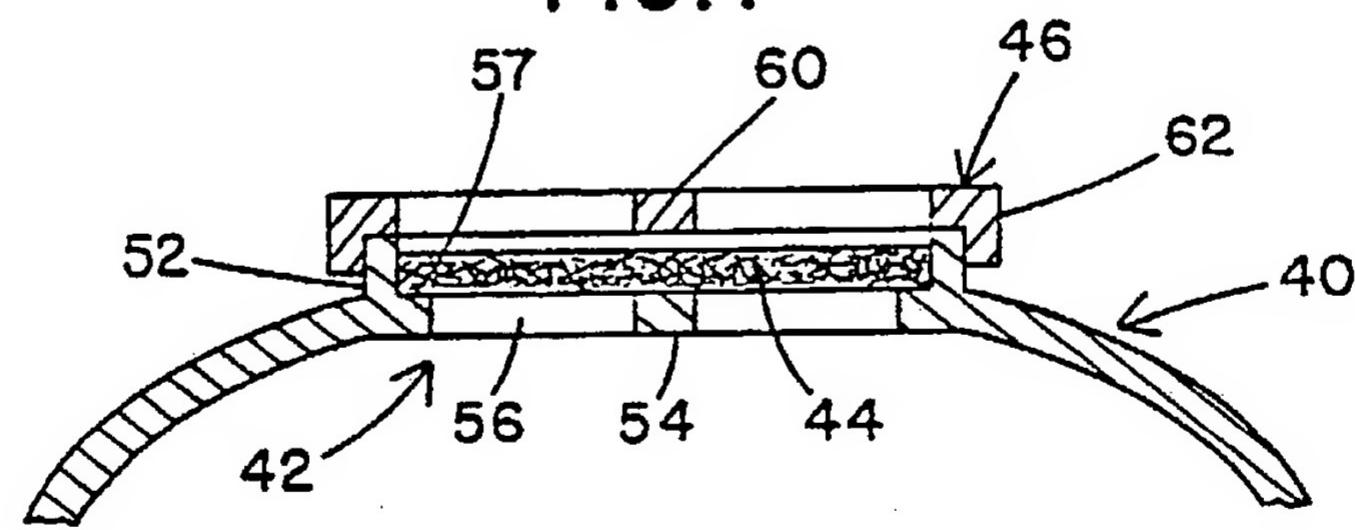


FIG.7



# INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/02848

## I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) <sup>13</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC  
**IPC (4): A62B 18/08**  
**U.S. Cl. 128/206.16, 206.19**

## II. FIELDS SEARCHED

Minimum Documentation Searched <sup>14</sup>

Classification System	Classification Symbols
U.S.	128/201.25, 205.25, 206.12, 206.13, 206.16-206.19, 206.21, 206.24, 206.28, 207.13

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched <sup>15</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>16</sup>

Category <sup>17</sup>	Citation of Document, <sup>18</sup> with indication, where appropriate, of the relevant passages <sup>19</sup>	Relevant to Claim No. <sup>18</sup>
X Y	GB, A, 1,077,791 (SECRETARY OF STATE FOR DEFENSE) 02 August 1967, see the entire document.	1-4, 7 5-6, 8
Y	AT, B, 87,635 (DEUTSCHE GASGLUHLICHT AKTIENGESELLSCHAFT) 10 March 1922, see the entire document.	5-6
Y	US, A, 2,931,356 (SCHWARZ) 05 April 1960, see the entire document.	1-4, 7-9
Y	AU, B, 117,262 (FAUST) 13 July 1943, see the entire document.	1-4, 7-9
A	CH, A, 209,470 (LEHMANN) 01 July 1940, see page 1, column 2, lines 11 et seq. and page 2, column 1, lines 1-8.	1-8
A	CH, A, 194,585 (OTT) 01 March 1938, see page 2, column 2, lines 22-31.	1-8

\* Special categories of cited documents: <sup>15</sup>

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search <sup>21</sup>

13 January 1988

Date of Mailing of this International Search Report <sup>22</sup>

01 MAR 1988

International Searching Authority <sup>23</sup>

ISA/US

Signature of Authorized Officer <sup>24</sup>

R.M. Rechtchie  
R.M. Rechtchie

## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A | GB, A, 275,940 (N.V. VEREENIGDE  
NEDERLANDSCHE RUBBERFABRIEKEN) 13  
October 1927, see page 2, lines 1-8.

1-8

V.  OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE <sup>10</sup>

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1.  Claim numbers \_\_\_\_\_ because they relate to subject matter <sup>12</sup> not required to be searched by this Authority, namely:

2.  Claim numbers \_\_\_\_\_, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out <sup>13</sup>, specifically:

VI.  OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING <sup>11</sup>

This International Searching Authority found multiple inventions in this international application as follows:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4.  As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

## Remark on Protest

- The additional search fees were accompanied by applicant's protest.  
 No protest accompanied the payment of additional search fees.